HIGH TRANSIENT DOSES AS A RESULT OF ACCUMULATION AND CHEMICAL ZONATION OF LONG-LIVED RADIONUCLIDES ACROSS THE GEOSPHERE-BIOSPHERE INTERFACE: IMPLICATIONS FOR PERFORMANCE ASSESSMENT

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Post-closure safety assessments for nuclear waste repositories (Performance Assessments, PA's) involve a radioecological analysis of the release to the surface environment from an underground source(s). The primary focus is the potential radiological impact on exposed populations and ecosystems. Development of dose evaluation models for such PA applications has been ongoing for over thirty years. At early stages of waste disposal programmes generic modelling was appropriate; the international Reference Biospheres Methodology has been developed to construct stylised biospheres based on present-day biosphere systems. Traditionally in long-term safety assessments geosphere and biosphere simulations are treated as distinct model domains.

In more advanced disposal programmes, for example in Sweden, an integrated modelling approach has recently been developed in which "landscape models", based on detailed site-specific data, are used to evaluate radionuclide accumulations in the biosphere together with associated doses. In this approach land uplift induced by climate evolution (glaciation cycles) and a number of connected biosphere objects are considered. However, the coupling between geosphere and biosphere simulations remains limited.

A transparent and credible dose assessment must demonstrate that all relevant features, processes and events have been handled appropriately in the dose assessment model. Current models lack appropriate representations in two areas, namely, 1. the geosphere-biosphere interface, and 2. radionuclide transport and accumulation in soils.

The scientific community has long recognised that transport processes at the geosphere- biosphere interface (GBI) may have a significant influence on doses calculated within the assessment. However, to date, the issue of the GBI has not been fully explored. The objective of the present work is to investigate accumulation and chemical zonation of long-lived radionuclides across the GBI by modelling studies. A review of recent experimental data is used to justify the modelling.

In the first phase of this study a generic landscape model with several inter-connected ecosystems is used to investigate radionuclide accumulation in the GBI. The initial release occurs to the material at the base of a river/lake subsystem ("accumulation ecosystem"). Bed sediments and the deeper GBI transition to farmland as a result of human action ("exposure ecosystem"). This situation differs from the traditional approach where constant ecological characteristics are assumed within model representations.

In the second phase of the study an augmented model of the soil-plant system has been implemented featuring (cf. traditional models) higher spatial resolution of the soil column, a dynamic plant compartment and the separation of the soil

porewater and solid phases. Results indicate a number of relevant features arising from this enhanced parameterisation.

Overall, simulation results show significant transient peaks in dose can occur in the “exposure ecosystem” due to prior concentration in the “accumulation ecosystem”. Doses return to the values expected for chronic release into the “exposure ecosystem” in the long term. We conclude that processes in the geosphere/biosphere transition zone must be modelled in more detail with special regard to ecosystem evolution and changes to hydrology at the local scale. In an evolving system the dynamics of the GBI in both space and time need to be clearly understood.